Space Weather Technical Forecast

Issued on Monday, 09 October 2023 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares. Slight chance G1 Minor Storm day 1-3 (09-11 Oct) from coronal hole fast winds. Chance G1-G2 Minor/Moderate storm intervals day 3-4 (11-12 Oct) due to CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with C6.6 flare observed peaking at 08/0340 UTC, from AR3460 in the southeast. There are nine sunspot regions visible. AR3451 in the northwest is the largest and most magnetically complex, with the development of delta spot. AR3460 in the southeast is the next most complex region, with ongoing growth also leading to the development of a small delta spot. The remaining regions are all smaller and simpler. A CME was observed from the C6.6 and has been assessed as being Earth-directed.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 by ACE and DSCOVR are indicative of Slow wind conditions, persisting at background speeds of 300-330 km/s. Density has been rising however, from average to peak above average, around 18 ppcc. Total interplanetary magnetic field (IMF) strength, Bt, has been weak, below 7nT. The north-south component, Bt, was mainly negative until 08/1830 UTC, then varied between positive and negative values, ranging -5 nT to +7 nT. Phi angle was mainly negative (toward the Sun) until 08/1800 UTC then become positive (away from the Sun). Geomagnetic activity has been Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was background. GOES16 high energy (greater than 2MeV) electron flux was background to moderate, peaking 274 pfu at 08/1630 UTC. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The observation at 09/0000 UTC was 5.60e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with isolated M-flares likely. There is a slight chance of very isolated X-flare, predominately from AR3451 or AR3460.

Solar Wind / Geomagnetic Activity: There is one Earth-directed CME, with expected arrival either late day 3 or early day 4 (11-12 Oct). Otherwise slow wind conditions are expected to give way to a transition into the fast winds of CH57/- later day 1 or day 2 (09-10 Oct) and then CH58/- later day 2 or day 3 (10-11 Oct). This will likely bring peak winds of around 500-600 km/s. Quiet, isolated Unsettled geomagnetic activity is forecast at first. This will increase to Unsettled to Active later day 1 or more likely day 2 (09-10 Oct) due to the arrival of any CIR (co-rotating interactivity region) ahead of the fast wind enhancements, before easing again. Later day 3 or early day 4 (11-12 Oct), activity will likely become Active with a chance of G1-G2 Minor/Moderate storms intervals due to any CME arrival.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, with a slight chance of enhancements, mainly if any notable flares from AR3451 occur. High energy electron flux (greater than 2MeV) is forecast to be at background to moderate levels throughout, dropping out with any fast wind or CME arrivals before potentially increasing again day 4 (12 Oct). Electron fluence is expected to remain below

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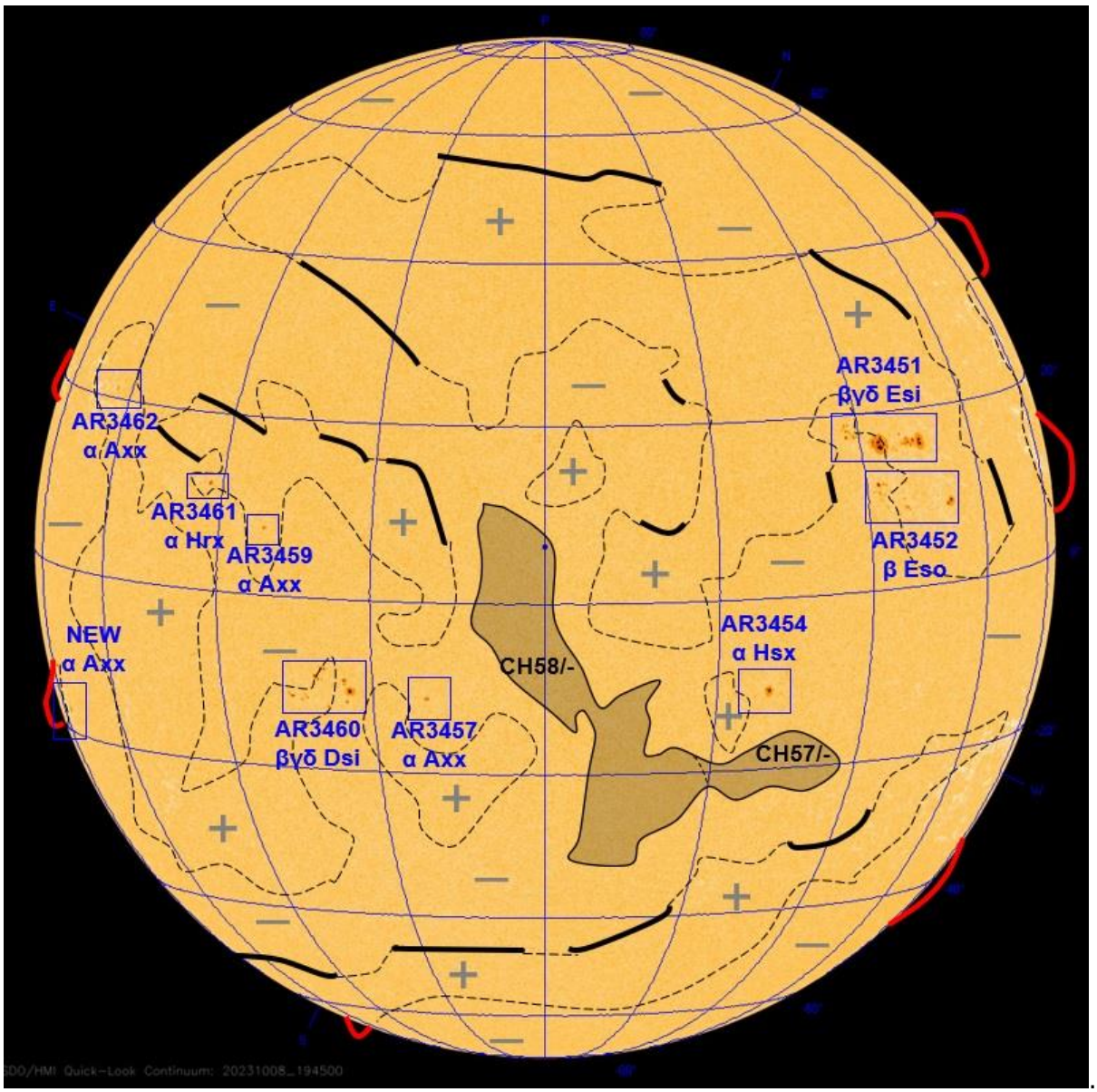
the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 08/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME, associated with the C5 flare of AR3460 at 08/0339 UTC, is expected to arrive at Earth late day 3 or early day 4 (11-12 Oct).

Slow wind conditions are expected at first, but with a chance of Earth moving into the fast wind of CH57/- later on day 1 (09 Oct) into day 2 (10 Oct). A transition is then expected later day 2 or early day 3 (10-11 Oct) into the broad high speed stream (HSS) from CH58/-. These fast winds are the expected to persist, likely at elevated levels of 500-600km/s, as supported by MOSWOC enlil, although this is currently considered too early with peak winds, most likely occurring later on day 3 (11 Oct).

Quiet, isolated Unsettled geomagnetic activity is forecast at first. This will increase to Unsettled to Active later day 1 or more likely day 2 (09-10 Oct) due to the arrival of any CIR (co-rotating interactivity region) ahead of the fast wind enhancements, before easing again. Negative coronal holes are less likely to give strong connections near the September equinox (Russell-McPherron effect) however there is still a chance of isolated G1 intervals. Later day 3 or early day 4 (11-12 Oct), activity will likely become Active with a chance of G1-G2 Minor/Moderate storms intervals due to any CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	30	30
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/1435	Partial	C6.6 AR3460	SE	460 km/s	Late 11 Oct/early 12 Oct	Arrival time very dependent on CH fast wind arrivals.

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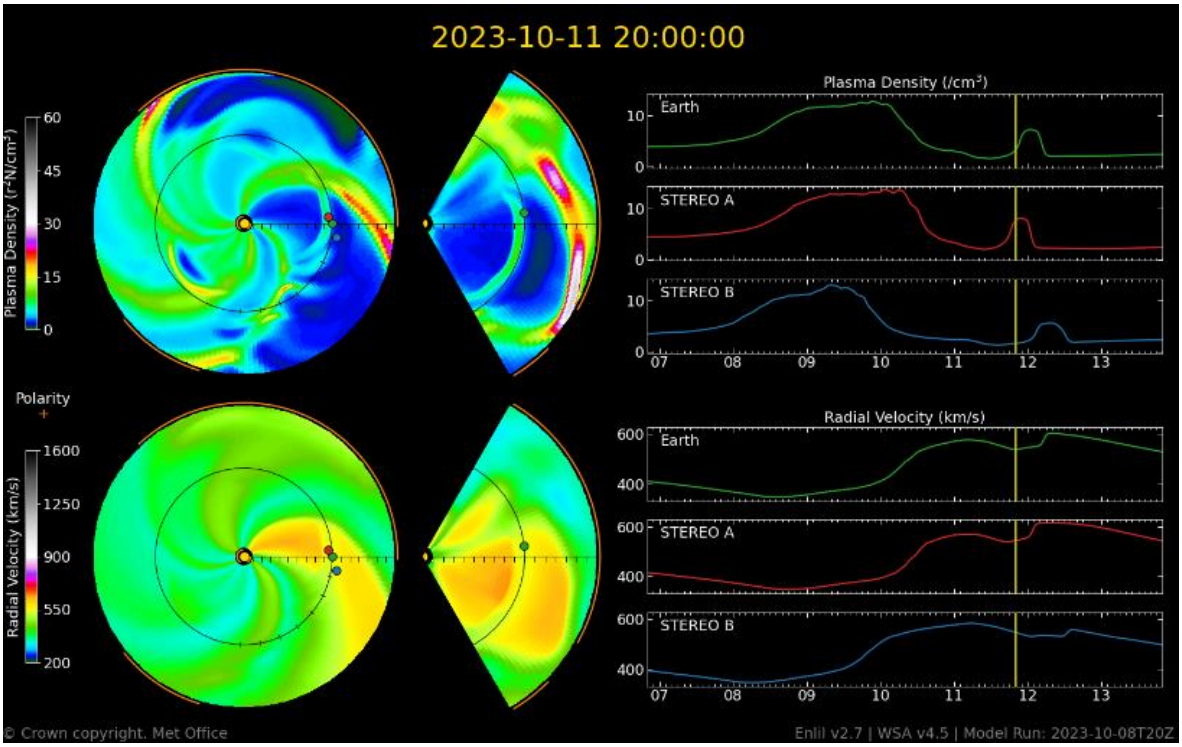
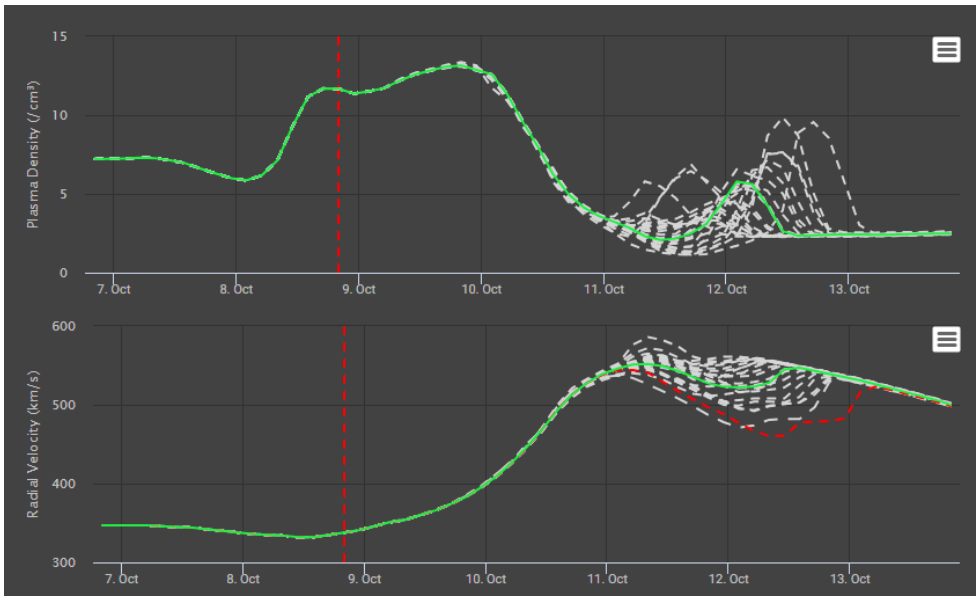
Figure 2: Enlil showing fast wind onset and CME arrival.





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Radio Blackouts - X-Ray Flares:

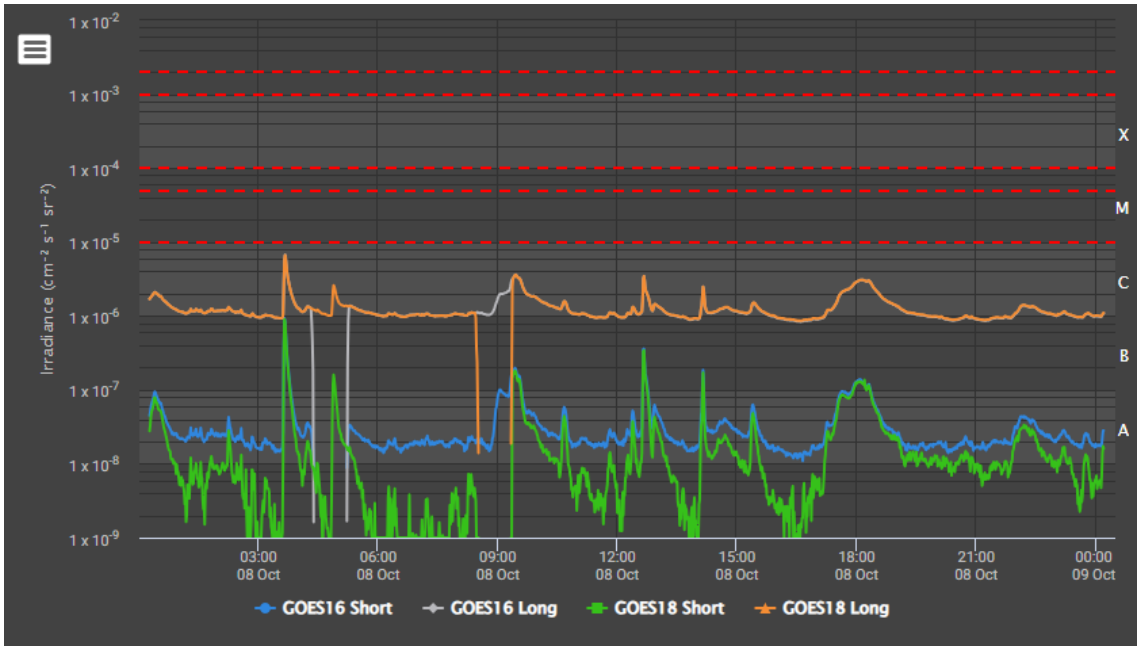
Solar Activity is forecast to be Low to Moderate with an ongoing chance of isolated M-class flares. There is a slight chance of activity increasing to High due to an isolated X-class flare, from either of AR3451 or AR3460.

Of the nine regions on the disc, AR3451 in the northwest is the largest and exhibits the greatest complexity. Over the last 24 hours a moderately sized spot has developed within this region, originally an intermediate spot but now the main trailer. This emerged near opposite polarity spots, resulting in a potentially unstable configuration with a delta-spot forming. A distinct north-south flux rope is also evident in SDO aia-211 imagery, with some s-shape curvature, connecting this spot to nearby AR3452, a weaker spot to the south of AR3451. Overall, this suggests an increased likelihood of M-flares, and a slight chance of X-flares.

AR3460 has also seen the emergence of small spots, two of which have mixed polarity, and therefore also has a delta configuration. This is currently a smaller region, with a lower potential for larger flares, however its complexity does suggest the potential for flaring, especially if any further growth occurs. The other regions on the disc are currently smaller and simpler.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	55	50
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: GOES16/18 X-ray flux



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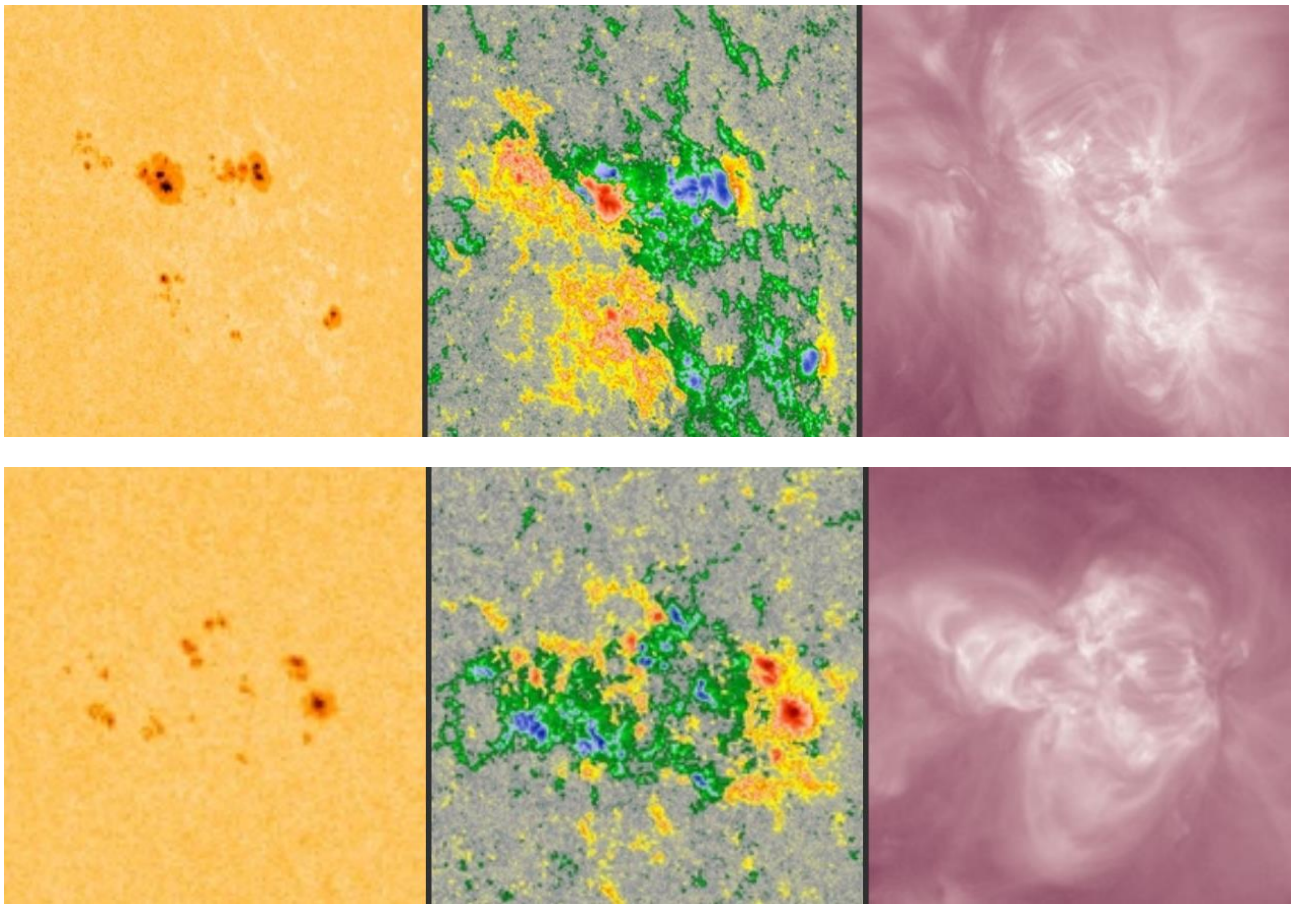
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels. AR3451 has developed a small delta spot however, and given its location on the northwest disc, this brings an increased potential for proton flux to rise should any notable flares occur from this region.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: SDO hmi-intensitygram, hmi-magnetogram and aia-211 of AR3451/52 (top) and AR3460 (bottom)



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has achieved moderate levels at the diurnal maximum in recent days. This is expected to continue through the period, with a slight chance of briefly reaching High levels during the diurnal max. The potential HSS arrivals from late day 1 until day 3 (09-11 Oct) could potentially bring a suppression in the flux, before a further increase is likely later in the period. This most likely by the end of day 4 (12 Oct).

Electron fluence is forecast to be well below the Active (1e8 integrated pfu) level throughout. MOSWOC REFM output is currently giving good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Flux and Fluence with REFM

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